Claims

1. A fuel cell power plant for providing electric power to a load, comprising:

a plurality of fuel cells having fuel flow channels arranged in a series of M fuel flow fields, the last fuel flow field in said series being the Mth fuel flow field in said series, and the first fuel flow field in said series being the (M-N)th flow field in said series, where N is one less than M, said series of fuel flow fields selected from (a) M fuel flow passes through the fuel flow channels of each cell, (b) the fuel flow fields of M groups of fuel cells in a serial fuel flow relationship within one cascaded fuel cell stack, in which the fuel is fed from each group but the last into the next group in the series, and (c) the fuel flow fields of M fuel cell stacks in serial fuel flow relationship in which fuel is fed from each stack but the last into the next stack in the series, each of said fuel flow fields connected between a fuel flow field inlet and a fuel flow field exit;

each of said fuel flow field inlets connected to a fuel manifold selected from (d) an internal fuel inlet manifold, (e) an external fuel inlet manifold, (f) an internal fuel turn manifold, and (g) an external fuel turn manifold;

each of said fuel flow field exits connected to a fuel manifold selected from (h) an internal fuel exit manifold, (I) an external fuel exit manifold, (j) an internal fuel turn manifold, and (k) an external fuel turn manifold;

a source of fuel;

said first flow field in said series receiving fuel from said source;

an additional fuel flow field in said series receiving fuel from said flow field next antecedent to said additional fuel flow field in

said series and either (l) directly from said source or (m) from said source through a fuel storage device which receives fuel from said source;

a fuel recycle loop receiving fuel from the one of said manifolds connected to the fuel flow field exit of said Mth one of said fuel flow fields and providing recycle fuel to either ®) a first one of said manifolds connected to the fuel flow field inlet of said Mth flow field in said series, or (s) a second one of said manifolds connected to the fuel flow field inlet of the (M-1th) flow field in said series, or (t) both said first and second manifolds;

each of said fuel cells having an oxidant flow field with an oxidant inlet and an oxidant outlet;

a source of pressurized oxidant connected to said oxidant inlets; and

said fuel recycle loop having an impeller selected from (u) a blower, (v) an electrochemical hydrogen pump, (w) a turbocompressor, the turbine of which is connected to and driven by oxidant exhaust from said oxidant outlets, and the compressor of which impels said recycle fuel, (x) an ejector having its input connected to said fuel flow field exit of said Mth flow field and having its output connected to one or both of said first and second manifolds.

2. A fuel cell power plant, comprising:

a plurality of fuel cells having fuel flow channels arranged in a series of M fuel flow fields, the last fuel flow field in said series being the Mth fuel flow field in said series, and the first fuel flow field in said series being the (M-N)th flow field in said series, where N is one less than M, said series of fuel flow fields selected from (a) M fuel

flow passes through the fuel flow channels of each cell, (b) the fuel flow fields of M groups of fuel cells in a serial fuel flow relationship within one cascaded fuel cell stack, in which the fuel is fed from each group but the last into the next group in the series, and (c) the fuel flow fields of M fuel cell stacks in serial fuel flow relationship in which fuel is fed from each stack but the last into the next stack in the series, each of said fuel flow fields connected between a fuel flow field inlet and a fuel flow field exit;

each of said fuel flow field inlets connected to a fuel manifold selected from (d) an internal fuel inlet manifold, (e) an external fuel inlet manifold, (f) an internal fuel turn manifold, and (g) an external fuel turn manifold;

each of said fuel flow field exits connected to a fuel manifold selected from (h) an internal fuel exit manifold, (I) an external fuel exit manifold, (j) an internal fuel turn manifold, and (k) an external fuel turn manifold;

a source of fuel;

said first flow field in said series receiving fuel from said source; and

a fuel recycle loop receiving fuel from the one of said manifolds connected to the fuel flow field exit of said Mth one of said fuel flow fields and providing recycle fuel to either (l) a first one of said manifolds connected to the fuel flow field inlet of said Mth flow field in said series, or (m) a second one of said manifolds connected to the fuel flow field inlet of the (M-1th) flow field in said series, or (n) both said first and second manifolds.

3. A fuel cell power plant for providing electric power to a load, comprising:

a plurality of fuel cells having fuel flow channels arranged in a series of M fuel flow fields, the last fuel flow field in said series being the Mth fuel flow field in said series, and the first fuel flow field in said series being the (M-N)th flow field in said series, where N is one less than M, said series of fuel flow fields selected from (a) M fuel flow passes through the fuel flow channels of each cell, (b) the fuel flow fields of M groups of fuel cells in a serial fuel flow relationship within one cascaded fuel cell stack, in which the fuel is fed from each group but the last into the next group in the series, and (c) the fuel flow fields of M fuel cell stacks in serial fuel flow relationship in which fuel is fed from each stack but the last into the next stack in the series, each of said fuel flow fields connected between a fuel flow field inlet and a fuel flow field exit;

each of said fuel flow field inlets connected to a fuel manifold selected from (d) an internal fuel inlet manifold, (e) an external fuel inlet manifold, (f) an internal fuel turn manifold, and (g) an external fuel turn manifold;

each of said fuel flow field exits connected to a fuel manifold selected from (h) an internal fuel exit manifold, (I) an external fuel exit manifold, (j) an internal fuel turn manifold, and (k) an external fuel turn manifold;

a source of fuel;

said first flow field in said series receiving fuel from said source; and

an additional fuel flow field in said series receiving fuel both (l) from a fuel flow field next antecedent to said additional fuel flow field in said series and (m) directly from said source.

4. A fuel cell power plant according to claim 3 wherein:

said additional flow field is the second flow field in said series.

5. A fuel cell power plant according to claim 3 wherein:

said additional flow field is the next-to-last flow field in said series.

6. A fuel cell power plant according to claim 3 wherein:

said additional flow field is the last flow field in said series.

7. A fuel cell power plant according to claim 3 wherein:

the next to last flow field in said series receiving fuel both from a fuel flow field next antecedent to said next to last fuel flow field in said series and directly from said source, and said last flow field in said series receiving fuel both from said next to last flow field in said series and directly from said source.

8. A fuel cell power plant according to claim 3 wherein:

the fuel flow from said source to said additional flow field is controlled in response to at least one of (n) a voltage generated in the fuel cells of said additional flow field (o) the concentration of fuel flowing through said additional fuel flow field, (p) the current flowing in said load, and (q) pressure of reactant gas flow exiting said additional flow field.

9. A fuel cell power plant, comprising:

a plurality of fuel cells having fuel flow channels arranged in a series of M fuel flow fields, the last fuel flow field in said series being

the Mth fuel flow field in said series, and the first fuel flow field in said series being the (M-N)th flow field in said series, where N is one less than M, said series of fuel flow fields selected from (a) M fuel flow passes through the fuel flow channels of each cell, (b) the fuel flow fields of M groups of fuel cells in a serial fuel flow relationship within one cascaded fuel cell stack, in which the fuel is fed from each group but the last into the next group in the series, and (c) the fuel flow fields of M fuel cell stacks in serial fuel flow relationship in which fuel is fed from each stack but the last into the next stack in the series, each of said fuel flow fields connected between a fuel flow field inlet and a fuel flow field exit;

each of said fuel flow field inlets connected to a fuel manifold selected from (d) an internal fuel inlet manifold, (e) an external fuel inlet manifold, (f) an internal fuel turn manifold, and (g) an external fuel turn manifold;

each of said fuel flow field exits connected to a fuel manifold selected from (h) an internal fuel exit manifold, (I) an external fuel exit manifold, (j) an internal fuel turn manifold, and (k) an external fuel turn manifold;

a source of fuel;

a fuel storage device which receives fuel from said source:

said first fuel flow field in said series receiving fuel from said source; and

an additional fuel flow field in said series receiving fuel from (l) a fuel flow field next antecedent to said additional fuel flow field in said series and from either (m) said fuel storage device or (n) said source.

10. A fuel cell power plant, comprising:

a plurality of fuel cells having fuel flow channels arranged in a series of M fuel flow fields, the last fuel flow field in said series being the Mth fuel flow field in said series, and the first fuel flow field in said series being the (M-N)th flow field in said series, where N is one less than M, said series of fuel flow fields selected from (a) M fuel flow passes through the fuel flow channels of each cell, (b) the fuel flow fields of M groups of fuel cells in a serial fuel flow relationship within one cascaded fuel cell stack, in which the fuel is fed from each group but the last into the next group in the series, and (c) the fuel flow fields of M fuel cell stacks in serial fuel flow relationship in which fuel is fed from each stack but the last into the next stack in the series, each of said fuel flow fields connected between a fuel flow field inlet and a fuel flow field exit;

each of said fuel flow field inlets connected to a fuel manifold selected from (d) an internal fuel inlet manifold, (e) an external fuel inlet manifold, (f) an internal fuel turn manifold, and (g) an external fuel turn manifold;

each of said fuel flow field exits connected to a fuel manifold selected from (h) an internal fuel exit manifold, (I) an external fuel exit manifold, (j) an internal fuel turn manifold, and (k) an external fuel turn manifold;

a source of fuel;

said first flow field in said series receiving fuel from said source;

a fuel recycle loop receiving fuel from the one of said manifolds connected to the fuel flow field exit of said Mth one of said fuel flow fields and providing recycle fuel to either (I) a first one of said manifolds connected to the fuel flow field inlet of said Mth flow

field in said series, or (m) a second one of said manifolds connected to the fuel flow field inlet of the (M-1th) flow field in said series, or (n) both said first and second manifolds;

each of said fuel cells having an oxidant flow field with an oxidant inlet and an oxidant outlet;

a source of pressurized oxidant connected to said oxidant inlets; and

said fuel recycle loop having an impeller selected from (o) a blower, (p) an electrochemical hydrogen pump, (q) an ejector having its input connected to said fuel flow field exit of said Mth flow field and having its output connected to one or both said first and second manifolds.

11. A fuel cell power plant, comprising:

a plurality of fuel cells having fuel flow channels arranged in a series of M fuel flow fields, the last fuel flow field in said series being the Mth fuel flow field in said series, and the first fuel flow field in said series being the (M-N)th flow field in said series, where N is one less than M, said series of fuel flow fields selected from (a) M fuel flow passes through the fuel flow channels of each cell, (b) the fuel flow fields of M groups of fuel cells in a serial fuel flow relationship within one cascaded fuel cell stack, in which the fuel is fed from each group but the last into the next group in the series, and (c) the fuel flow fields of M fuel cell stacks in serial fuel flow relationship in which fuel is fed from each stack but the last into the next stack in the series, each of said fuel flow fields connected between a fuel flow field inlet and a fuel flow field exit;

each of said fuel flow field inlets connected to a fuel manifold selected from (d) an internal fuel inlet manifold, (e) an external fuel

inlet manifold, (f) an internal fuel turn manifold, and (g) an external fuel turn manifold;

each of said fuel flow field exits connected to a fuel manifold selected from (h) an internal fuel exit manifold, (I) an external fuel exit manifold, (j) an internal fuel turn manifold, and (k) an external fuel turn manifold;

a source of fuel;

said first flow field in said series receiving fuel either (l) directly from said source or (m) from said source through a fuel storage device which receives fuel from said source.